RESEARCH PRIORITIES FOR FY 1999

The U.S. Geological Survey Earthquake Hazards Reduction Program(USGS-EHRP) sponsors, through its External Research Program (ERP), a wide range of studies applicable to earthquake risk reduction in the United States. Funding decisions in the ERP are made by six regional panels. Each panel evaluates research aimed at the program elements. The program emphasizes certain geographic regions based upon specific earthquake hazards and associated societal risks in them.

The Research Priorities presented here were reviewed and modified from the current FY 1998 priorities with the new Earthquake Hazards Program five year science plan in mind. Full implementation of the new five-year plan will be in fiscal year 2000.

In response to guidance from the United States Congress, USGS-EHRP places high priority on investigations in four areas where large populations are exposed to significant seismic risk: Southern California, Northern California, the Pacific Northwest, and the Central United States. Studies in other earthquake-prone regions of the United States and Japan are also sponsored by the National-International panel. In addition, the Processes, Theoretical, and Laboratory Studies panel supports basic and applied research that can lead to new tools for earthquake hazard reduction nationwide.

Each proposal should be directed to a specific regional peer review panel, as listed below:

- **Southern California (SC):** From the Carrizo Plain south to the international border with Mexico
- **Northern California (NC):** From Cape Mendocino south to Parkfield, including the San Francisco Bay area
- **Pacific Northwest (PN):** Washington, Oregon, and California north of Cape Mendocino (Cascadia) and Alaska
- **Central United States (CU):** The New Madrid seismic zone and surrounding areas
- **National/International (NI):** All earthquake-prone geographic areas not included in the above four regions
- **Processes, Laboratory, and Theoretical (PT):** Basic and applied research that has potential for reducing earthquake hazard in many geographic areas.

Pages 7-9 of this announcement describes the process of proposal evaluation by each regional panel.

Regional coordinators may be able to assist applicants by describing related work within the USGS, identifying existing relevant data sets, and helping applicants establish contacts with USGS researchers working in similar areas. Regional Coordinators are listed on page 8 of this Announcement.

The two program elements described below were identified through USGS and independent external review. Following each element description is a list of Priority Tasks for each regional panel. We emphasize that this listing of Priority Tasks is not intended to discourage submission of proposals to accomplish other important tasks.

ELEMENT I. Products for Earthquake Loss Reduction

The USGS will produce and demonstrate products that enable the public and private sectors to assess earthquake hazards and implement effective mitigation strategies.

A key contribution of the USGS earthquake program is the series of national probabilistic seismic shaking hazard maps that are produced and updated periodically with new and refined information. These maps have grown out of the research efforts and systematically quantify the seismic shaking hazard for our nation. They are used as

input for policy decisions on building codes and land use. In support of these maps, the USGS will produce accessible GIS databases of active earthquake source zones with up-to-date information on slip rates and recurrence intervals.

For urban areas at high risk from earthquakes, the USGS plans maps and other products to quantify shaking amplification and susceptibility to liquefaction and landslides. These products will be incorporated into the Federal Emergency Management Agency's (FEMA) loss reduction efforts. In response to requests from city planners, earthquake scenarios of large urban earthquakes will be developed for public planning. Synthetic modeling of hypothetical ground motions will be provided to engineers to meet their needs in structural designing.

In Southern California

- Compile seismic, geotechnical and geologic data from both surface and from drill-hole observations necessary to predict regional ground motions and develop models to estimate variations in expected ground motions, accounting for bedrock excitation, site effects, duration of shaking, and soil-structure interaction.
- Develop and verify methods for calculating time histories of strong ground motion. Produce synthetic time histories for scenario earthquakes in the Los Angeles and San Bernardino regions.
- Develop credible planning earthquake scenarios for Los Angeles and San Bernardino regions.
- Evaluate capability and effectiveness of realtime damage assessment and warning systems that have been developed for southern California.
- Compile and provide access to geotechnical, structures, and seismic databases that will provide useful information for mitigation and emergency response efforts.

In Northern California

- Develop quantitative ground motion models and maps that account for site effects, duration of shaking, and directivity for scenario earthquakes in the San Francisco Bay area.
- Develop models to explain and quantify the effects of fault interaction with particular emphasis on the earthquake cycle in the San Francisco Bay Area.
- Maintain and improve existing fault monitoring networks with downhole strain, geodetic, and creep measurements in northern California.
- Develop geotechnical information to model the location and amount of permanent ground deformation expected from Bay Area scenario earthquakes.
- Compile and provide access to geotechnical, structural, and seismic databases that will provide useful data for developing mitigation techniques and planning emergency response efforts.

In the Central United States

- Develop models to explain the genesis of large earthquakes in plate interiors in general and in the New Madrid seismic zone in particular.
- Compile existing data to prepare 1:250,000-scale earthquake hazard maps for the New Madrid seismic zone.
- In the Central United States, collaborate with the USGS, working groups, professional organizations, and regional consortia to develop the most effective means to communicate seismic hazard issues and to better determine the needs of user groups.

In the Pacific Northwest

- Model the effect of the sedimentary basins in the Portland and Puget Sound metropolitan areas on strong ground motions expected from subduction-zone, crustal, and Benioff zone earthquakes.
- Develop models to explain the interaction between the subducting Juan de Fuca plate and North America plate in the Pacific Northwest.

- Extend the capabilities of the real-time seismic systems in Alaska and Cascadia to improve the integration of strong ground motion and broad-band data into the rapid delivery of earthquake information to the National Seismic System.
- Compile and provide the ability to electronically access geotechnical, building characteristics, or seismic databases for use in earthquake mitigation, response, or recovery planning.

In Other Regions of the United States and International

- Compile new and upgrade existing data that provide input information for seismic hazard maps. Examples of the types of data include moment-magnitude-based earthquake catalogs from regional network data and historical information for earthquakes of magnitude 4 and greater in western North America and magnitude 3 and greater in central and eastern North America, information on the location and characteristics of active faults, and regional or local information on attenuation properties or ground-motion amplification that would impact hazard assessments.
- Identify the range of geological and geotechnical conditions present in the Boston metropolitan area and their effect on potential variations in strong ground shaking. These data will be used to evaluate the appropriateness of large scale seismic hazards mapping in the Boston area.
- Develop improved regionally specific ground-motion attenuation relations in the central and eastern USA.
- Determine recurrence intervals, slip rates, and segmentation characteristics and uncertainties of poorly studied active faults that directly affect the hazard in highly populated urban areas.
- In consultation with USGS geodesists studying crustal deformation, develop a prototype geodetic database designed to quantify neotectonic deformation at a national scale.

In Processes, Theoretical, and Laboratory Studies

- Develop criteria for basin selection and a methodology for modeling 3-D earthquake wave propagation in sedimentary basins. Test the methodology in well-characterized basins.

ELEMENT II. Research on Earthquake Occurrence and Effects

The USGS will pursue earthquake research to understand earthquake occurrence and effects for the purpose of developing and improving hazard assessment methods and loss reduction methodologies.

Because all of the current USGS products of the earthquake program have developed from its research efforts, the USGS will continue a major focus on understanding earthquake occurrence in space and time. The physical conditions for earthquake rupture initiation and growth need to be elucidated with field measurements in fault zones and modeling of seismicity, crustal deformation, and other earth science data. Additional areas of interest include earthquake triggering, fault interactions, and the role of aseismic slip in relieving the buildup of crustal strain. Understanding in these areas will lead to better estimates of the long-term seismic hazards to our country. To address short-term seismic hazard evaluations, work on earthquake statistics and evaluations of stress fields associated with large earthquakes may facilitate estimates of likelihood and location of future earthquakes.

Reducing future earthquake losses depends on an understanding of the damaging effects of earthquakes. Using data from our regional seismic networks, research in this area will address how complexities in the earthquake source, wave propagation effects, and near-surface geological deposits control the strong shaking. Studies will also investigate the factors that govern susceptibility to ground failure from landsliding, liquefaction, and lateral spreading.

In Southern California

- Investigate Quaternary faulting and develop regional models of active deformation.
- Use waveform data to determine earthquake source parameters and crustal structure.

- Develop and verify methods for calculating time histories of strong ground motion.
- Characterize the behavior of active faults segments and clarify differences between seismic and aseismic processes. The Los Angeles, Ventura, and San Bernardino basins are of particular interest.
- Conduct geodetic and modeling studies in the Los Angeles, Ventura, and San Bernardino basins. Evaluate the consistency between geodetic and seismic slip rates.

In Northern California

- Determine paleoearthquake chronologies and refine slip-rate and recurrence estimates and evaluate segmentation models for major faults of the San Andreas system, in the following priority: San Andreas, Hayward-Calaveras, Concord-Green Valley, Rodgers Creek, Greenville,, Mayacama, and San Gregorio faults.
- Use waveform data to define the 3-dimensional structure of the crust.
- Characterize the extent, structure, geometry, and stratigraphy of basins in the San Francisco Bay region, with particular emphasis on the Santa Clara valley
- Determine the geometry, location, and rate of deformation on fold and thrust-fault structures in the San Francisco Bay Area and quantify the rates of compressional deformation associated with surface and blind thrust faults.

In the Central United States

- Determine rates and character of active crustal deformation in seismogenic areas by assessing old and collecting new geodetic data at both local and regional scales. Synthesize the data to improve the understanding of the tectonic setting of regional seismicity. Evaluate GPS monument stability and noise levels in unconsolidated sediments of the Mississippi Valley region.
- Conduct investigations to determine spatial and temporal characteristics of prehistoric earthquakes. Expand the regional coverage of such investigations beyond the area of current microseismicity in the northern Mississippi embayment to locate other possible source zones.
- Identify the range of geological and geotechnical conditions present in the Memphis metropolitan area and their affect on potential variations in strong ground shaking. These data will be used to evaluate the appropriateness of large scale hazard mapping in the Memphis area.

In the Pacific Northwest

- Conduct field investigations for evidence of ground shaking or displacement associated with the possibility of late Holocene crustal earthquakes throughout the Puget Sound region.
- Conduct cooperative seismic imaging experiments to compliment the recording and/or analysis of the land portion of the USGS experiment Seismic Hazards Investigations in Puget Sound (SHIPS).
- Develop models that examine the effect of the long durations expected from subduction zone events on predicted ground motions.
- Conduct field investigations and develop models using existing observations necessary to understand crustal deformation in Cascadia. Proposed measurements in Cascadia must be integrated into a single a regional crustal deformation strategy.
- Identify and characterize active tectonic structures in the Portland and/or Seattle metropolitan area.
- Conduct field investigations for evidence of late Holocene ground shaking or displacement in the greater Anchorage area associated with past subduction zone, crustal, and Benioff zone events.
- Study the relations between the subduction tectonic framework and the distribution of crustal seismicity in the southern Alaska region.

In Other Regions of the United States and International

- Develop regionally specific ground-motion time histories and validate against observed ground-motion records. Devise methods of making these time histories available to the earthquake hazard community.

- Conduct Quaternary geologic, geomorphic, and paleoseismic investigations (including paleoliquefaction studies) and companion geophysical surveys to determine the spatial and temporal distribution of prehistoric earthquakes in earthquake-prone parts of the U.S. and U.S. Territories in the Caribbean region.
- Use inferred ground-motion from detailed damage data to determine which ground-motion parameters are correlated best with building performance in order to determine alternative parameters for the National Seismic Hazard maps.
- Identify the range of geological and geotechnical conditions present in the Boston metropolitan area and their effect on potential variations in strong ground shaking. These data will be used to evaluate the appropriateness of large-scale seismic hazards mapping in the Boston area..

In Processes, Theoretical, and Laboratory Studies

- Conduct field studies of active and exhumed fault zones to gain knowledge of stresses, fluid pressure, temperature, pore fluid chemistry, and internal fault zone structures of earthquake rupture zones.
- Conduct laboratory studies to determine the mechanical and physico-chemical behavior of rocks and fault gouge under pressures and temperatures expected at seismogenic depths.
- Collect and interpret data documenting aseismic fault slip processes.
- Develop and test guidelines for interpreting fault stepovers, geometric irregularities and material property contrasts as delimiters of earthquake source zones in a range of tectonic environments.
- Implement conceptual and theoretical models of the earthquake process as computer software that can simulate both quasistatic and spontaneous seismic slip on major strike-slip or dip-slip faults at a regional scale. Test simulations using field and laboratory data and identify additional data that would constrain simulation parameters. Investigators should propose documented software as a product and build on existing software when possible.
- Formulate and test hypotheses on the initiation, propagation, and arrest of seismic rupture and their implications for earthquake source effects on strong ground motion.
- Determine the physical mechanisms linking foreshocks to mainshocks, with long-term goals of more accurately calculating foreshock probabilities and developing public warning capability based on the identification of foreshocks.
- Design and carry out field investigations to measure stress, fluid pressure, or other changes which may be critical in post-earthquake stress transfer or help distinguish foreshocks from isolated moderate earthquakes.
- Improve estimates of long-term earthquake probabilities, especially by quantifying and determining physical reasons for the variability of recurrence times on identified fault segments.
- Investigate whether high strain rates measured using geodetic techniques such as GPS indicate enhanced potential for damaging earthquakes in any part of the United States.
- Determine the mechanisms by which significant earthquakes modify background seismicity in their immediate vicinities and trigger earthquakes at large distances, with the goal of issuing rapid public assessments of earthquake threat modification following major earthquakes.
- Test assumptions about earthquake recurrence used to construct the National Probabilistic Hazard Maps.
- Collect field data and conduct laboratory experiments to improve our fundamental understanding of the processes leading to liquefaction, lateral spreading, and slope failure during earthquakes.
- Analyze existing data to examine the response of structures, to identify the parameters of ground motion that control damage to structures, and investigate soil structure interaction
- Continue the focused fault-monitoring effort at Parkfield, California.
- Monitor deformation, fluid pressure, or electrical and magnetic fields to attempt recording of signals that could be earthquake precursors, and conduct field, laboratory, and theoretical investigations into the mechanisms of such precursors. **Note:** Proposals to study electrical and/or magnetic effects must address the goals published in "U.S. Geological Survey Plans and Goals for Earthquake-Related Electromagnetic Studies" (U.S. Geological Survey Open-File Report 96-71) which may be obtained from the External Research Program Office.